UNPACKING the TEKS | B.6(G)

In this lesson, you will learn about a type of cell division called meiosis. Meiosis produces cells that have only half the number of chromosomes as the parent cell. Sperm and egg cells are produced by meiosis.

A **homologous chromosome** is one member in a pair of matching chromosomes. One chromosome of the pair comes from the male parent and the corresponding chromosome comes from the female parent.

A **diploid cell** contains both of the chromosomes of a homologous pair.

A **gamete** is an egg cell or a sperm cell.

Mitosis is the part of the cell cycle in which the nucleus divides into two nuclei. Both nuclei have the same number and kind of chromosomes.

Meiosis is a part of the cell cycle in which the nucleus divides twice to produce four cells. The chromosome number in each cell is reduced by half. The process is used to form gametes that can participate in fertilization.

A **haploid cell** has only one set of chromosomes from a homologous pair.

Chromatids are the two exact copies of DNA that make up each chromosome after the chromosome copies itself.

Crossing over is a process in which homologous chromosomes exchange genetic information.

Words to Know

- homologous chromosome
- diploid cell
- gamete
- mitosis
- meiosis
- haploid cell
- chromatid
- crossing over

GUIDED INSTRUCTION

DIRECTIONS Read the selection below. Follow the instructions and answer the questions in the side column.

The human body is made mostly of cells called body cells. These body cells have 46 chromosomes. Of the 46 chromosomes in each human body cell, 23 come from one parent and the other 23 corresponding chromosomes come from the other parent. The two sets of matching chromosomes are called **homologous chromosomes**. A cell such as a body cell that contains both sets of homologous chromosomes is said to be diploid. The number of chromosomes in a **diploid cell** is represented by 2N. For example, human body cells would be represented by 2N = 46. The body cells of a fruit fly each contain 8 chromosomes, which would be written 2N = 8.

Many organisms, including all plants and animals, reproduce by joining **gametes**—a sperm cell and an egg cell. This process, called *fertilization*, begins a complex series of steps that leads to the development of an adult organism. The fertilized egg cell contains

Guided Questions

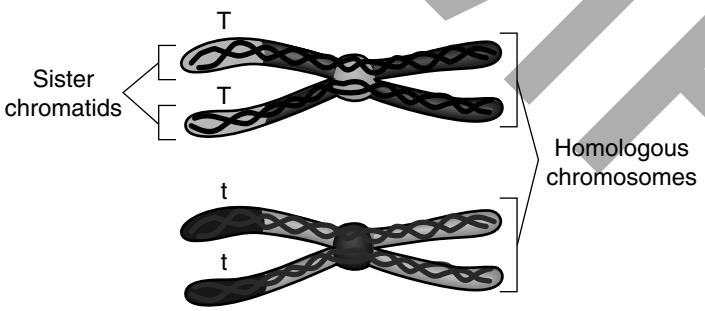
How is a diploid cell related to homologous chromosomes?

What is a gamete?

the same number of chromosomes that is found in any body cell of the parent. How is it possible for the fertilized egg cell and the parent body cell to have the same number of chromosomes when a fertilized egg is produced when two cells join? When this happens, should the chromosome number of the fertilized egg be twice the diploid number?

The answer to this question is in the process that organisms use to produce gametes. When body cells reproduce, they do so using **mitosis**. Mitosis produces cells that contain exact copies of the chromosomes in the parent cell. In mitosis, the chromosomes are copied once during DNA replication. The nucleus then divides once. As a result, each new cell produced by mitosis receives the same number of chromosomes as the parent cell. Each new cell is a diploid cell and is also identical to the parent cell.

However, when an organism produces gametes, it uses a process that is different from mitosis. This process is called **meiosis**. Meiosis results in cells that have half the number of chromosomes of the parent cell. These cells are called **haploid cells**, and they are represented by 1N. A human gamete would be represented by 1N = 23. Just as in mitosis, before meiosis begins, each chromosome makes an exact copy of itself. The two resulting chromosomes are actually called **chromatids**. The chromatids are attached together.



Notice that the two chromatids of the above homologous pair carry an allele labeled *T*. The other two chromatids carry an allele labeled *t*. Assume that these two alleles determine the height of a pea plant, so that the dominant allele *T* determines tall height, while the recessive allele *t* determines short height.

After each chromosome makes a copy of itself, the process of meiosis begins. During meiosis, the cell undergoes two cell divisions called *meiosis I* and *meiosis II*. To make it easier to follow what happens during meiosis, only two pairs of homologous chromosomes are shown in the following diagram. However, keep in mind that the organism contains many more chromosomes that are undergoing the same processes that are shown for these two homologous pairs.

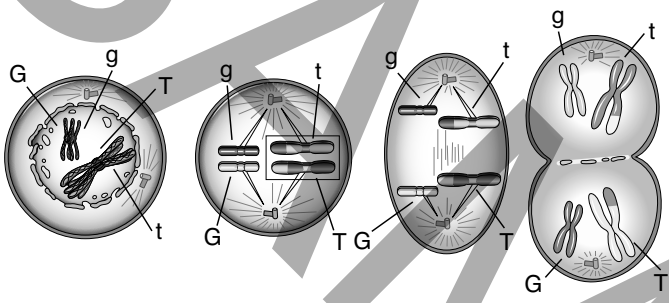
At the start of meiosis I, the nuclear membrane disappears, and the chromosomes thicken and shorten. Then homologous pairs

Guided Questions

How does a haploid cell differ from a diploid cell?

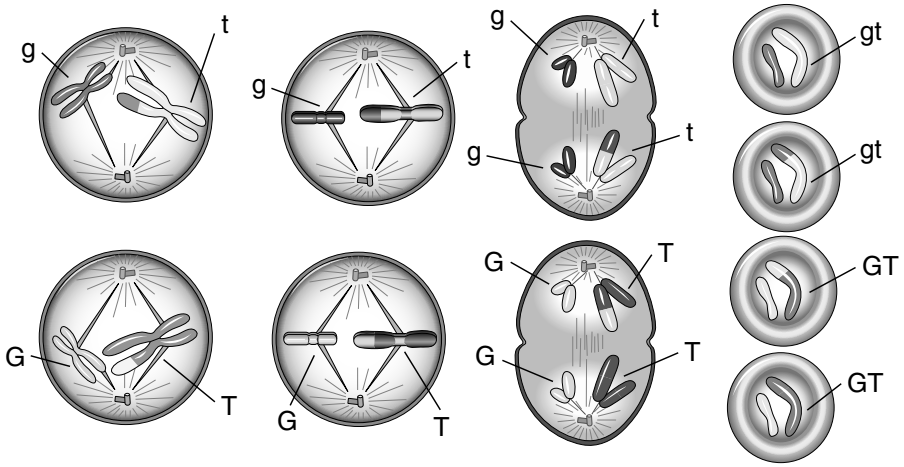
line up along the equator, or middle of the cell. Take a look at the diagram and notice the homologous pairs carrying the alleles *T* and *t*. The shaded areas on these pairs represent the genes on the chromosome and how they have exchanged genetic information with each other. This is known as **crossing over**. Crossing over occurs when homologous chromosomes pair up and exchange genetic information.

Next, the chromosomes separate from their homologous partners and move to opposite ends of the cell. Finally, the cell divides. Notice that one pair of our homologous chromosomes carries the alleles *T* and *t*, while the other homologous chromosome pair carries the alleles *G* and *g*.



The chromosome number has been reduced in half because the new cells contain two chromosomes. Each of these chromosomes consists of two sister chromatids that are still joined. The new cells produced in meiosis I now go through a second cell division during meiosis II. However, the two new cells are not copied before the process begins.

At the beginning of meiosis II, the chromosomes in each cell line up along each cell's center. Then the two chromatids split. Once the sister chromatids have separated, each is considered a chromosome. The chromosomes move to opposite ends of the cell, and a membrane forms around each set of chromosomes. The cells separate, and four haploid cells are produced. The steps in the second division are shown in the illustration below.



Guided Questions

What happens to homologous pairs of chromosomes when meiosis begins?

Compare the number of chromosomes in each cell at the beginning and the end of meiosis I.

Compare the number of chromosomes at the end of meiosis to the number of chromosomes in the parent cell.

Each of the four gametes produced by meiosis is haploid—it has half the number of chromosomes of the original cell. These four gametes are also different from each other and the parent cell. Notice that two of the four gametes contain the alleles *GT*, while the other two gametes contain the alleles *gt*. The original cell contained the genotype *GgTt*.

Guided Questions

1. The gametes of a pea plant contain seven chromosomes. How many chromosomes does a pea plant cell, such as one found in its stem, contain?

2. What happens to a parent cell at the end of meiosis I?

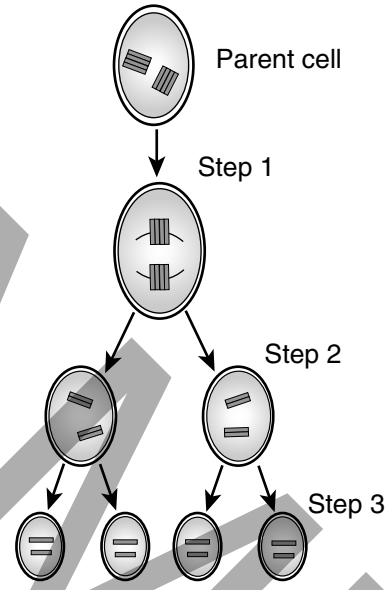
3. Why does meiosis result in 1N cells rather than 2N cells?

4. Describe two ways in which meiosis differs from mitosis.

CRITICAL THINKING

DIRECTIONS Read the paragraph, study the diagram, and answer the questions.

The illustration below summarizes what happens to the body cell for a particular organism. Look closely at what happens to the chromosomes at each step.



1. What process is shown in the diagram?

2. Suppose all the chromosomes for this organism are shown in the diagram. What is the diploid number of chromosomes for this organism?

3. What kind of cells are being produced in this process? Explain your answer.

4. Describe what happened to the chromosome number in this cell as a result of this process.

★ PRACTICE

DIRECTIONS Read each question and choose the best answer. Then circle the letter for the correct answer.

1 Which of the following occurs in meiosis?

A The chromosomes are copied twice.

B One cell produces four cells.

C One cell produces two cells.

D The nucleus divides once.

2 Which represent human body cells?

F 2N = 23

G 2N = 46 – 23

H 2N = 8

J 2N = 46

3 Which statement correctly describes what happens as a result of the first division that occurs during meiosis?

A Sister chromatids separate.

B The chromosome number remains unchanged.

C Each cell contains half the number of chromosomes of the original cell that started the process.

D Four gametes are formed.

4 What would most likely happen to the alleles for two different traits during meiosis if they were located on the same chromosome?

F They would obey Mendel's law of independent assortment.

G They would be distributed into different gametes.

H They would segregate from one another.

J They would remain together and pass into the same gamete.

5 If a parent cell has 18 chromosomes, how many chromosomes would be found in a gamete that this cell produces?

A 36

B 18

C 9

D 6

6 How are the gametes produced by meiosis alike?

F They contain the same number of haploid chromosomes.

G They will go through meiosis a second time.

H They have the same combination of alleles.

J They contain homologous pairs of chromosomes.

★ ASSESSMENT

DIRECTIONS Read each question and choose the best answer. Then circle the letter for the correct answer.

1 Which process occurs in both mitosis and meiosis?

A Cell specialization

B DNA replication

C Pairing of homologous chromosomes

D Reduction in chromosome number

2 Which genotype would illustrate Mendel's law of independent assortment as explained by meiosis?

F DdEe

G DD

H Dd

J ee

3 A student wanted to show her lab partner the process of meiosis. She set up a slide of cells about to undergo meiosis and asked her lab partner to look at them under a microscope. Where should she tell her lab partner to focus?

A The cytoplasm

B The space between the cells

C The nucleus

D The cell membrane

4 Which statement is true?

F Each new cell during meiosis receives the same number of chromosomes as the parent cell. Each new cell is a diploid cell.

G In meiosis, each new cell produced receives a different number of chromosomes as the parent cell. Each new cell is a diploid cell.

H Each new cell produced by mitosis receives the same number of chromosomes as the parent cell. Each new cell is a diploid cell.

J In mitosis, each new cell receives the same number of chromosomes as the parent cell. Each new cell is a haploid cell.

5 A body cell that contains both sets of homologous chromosomes is a —

A haploid

B diploid

C chromatid

D gamete

6 A cell that has only one set of chromosomes from a homologous pair is a —

F haploid

G diploid

H chromatid

J gamete